

70cm EME

Thomas Henderson WD5AGO

Tulsa Community College



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Thoughts on Getting Started

- Transceivers
 - Out of the box (IC706II) or Converters
- Amplifiers
 - Vacuum Tubes or Solid State
- LNAs
 - Commercial or Home Brewed
- Antennas
 - Commercial or Home Brewed

Operating Events

- Contest
 - 2 or more a year
- Special Events
 - Large Stations i.e..... Arecibo
- Classroom Demonstrations
- Radio Astronomy

EME Link Budget

- Based on two EME station scenarios:
 - 23 to 24 dB gain Array
 - 4 Long Yagis > 13 wl
 - 8 Mid Yagis > 7 wl
 - 16 Short Yagis > 2.5 wl
 - Arecibo, 56 dB gain
 - 1000' Dish

2 MHz 260.33 dB 40 K 150 Hz 1.00 mm 12.7 mm -161.0 dBm 2.9 dB

Path Loss T Sky Rx BW -26.2 dB Effective ground T*K 235 °K 0.01 dB C/S - ground -> 2.2 dB

<< Your last sfu data record has been loaded.

17.2 °K 17.2 °K 13 °K 1 °K 0.25 dB 0.25 dB 30.0 dB 2.0 dB 1.0 dB 80 °K 20 °K 10.1 dB

LNA Loss LNA NF LNA Gain Coax Loss Rx NF Spillover Feedthru Sun Y

Tx A Output Power Transmission Loss Power at Feed Moon Y

112 Watts 20.49 dBW 0.5 dB 100 Watts 19.99 dBW 40,665 W EIRP

T*K 35.7 °K = 0.50 dB Receiver Noise Temperature 290 °K 62 °F Sys T*K 175.7 °K = 2.06 dB System Noise Temperature

Dx Station as received at Home Station ... 0.6 dB

Home Station as received at Dx Station ... 0.5 dB

B (Dx Station) Default

32 MHz 260.33 dB 40 K 150 Hz 1.00 mm 12.7 mm -160.9 dBm -1.7 dB

Path Loss T Sky Rx BW -26.2 dB Effective ground T*K 241 °K 0.01 dB C/S - ground -> 2.4 dB

<< Your last sfu data record has been loaded.

17.2 °K 17.2 °K 45 °K 1 °K 0.25 dB 0.25 dB 30.0 dB 5.3 dB 1.0 dB 70 °K 20 °K 8.4 dB

LNA Loss LNA NF LNA Gain Coax Loss Rx NF Spillover Feedthru Sun Y

Tx B Output Power Transmission Loss Power at Feed Moon Y

112 Watts 20.49 dBW 0.5 dB 100 Watts 19.99 dBW 24,222 W EIRP

Single Yagi Gain in dbd 12.55 dBd 16 8.1 ° 23.95 dBd

Parabolic Reflector

Diameter Size f/D Efficiency Beam Width Gain Dis

31.17 ft Imperial 0.00 1% 5.11° 7837 7.91 dBd

37.0 Lambda

Home Station ... Y Factor Calc

Noise Source Quiet Source

Sagittarius Termination

Cassiopeia Aquarius

Cygnus Leo

Taurus A Taurus

Virgo

Termination

Noise Information Y Figure Notes

Noise Flux Quiet Flux

290 °K 40 °K

Point Source Y Factor

290 °K 286 °K 2 °K

Aperture Source Y Factor

Yagi Array

Number of Yagis E 10.5 °

Single Yagi Gain in dbd 16.00 dBd 4 10.5 °

Beam Width 21.70 dBd

Parabolic Reflector

Diameter Size f/D Efficiency Beam Width Gain Dis

2.50 m Metric 0.43 63% 19.43° 81 16.90 dBd

Dish diameter is less than 10 l

Effective Aperture 15.61 M²

Beam Width Ratio Note Both Moon and Sun correction

Moon Beam Fill Factor

Based on VK3UM EME Tool
For 24 dB gain System

32 MHz 260.33 dB 20 K 150 Hz 2.00 mm 9.0 mm -152.9 dBm 57.8 dB

frequency Path Loss T Sky Rx BW -37.7 dB Effective ground T*K 277 *K
0.00 dB C/S - ground -> 5.8 dB

GET PS SFU DATA << Your last sfu data record has been loaded.

6.8 *K 28.0 *K 21 *K 0 *K

80 0.10 dB 0.40 dB 33.0 dB 2.0 dB 1.0 dB 21 *K 0 *K 39.1 dB

Star Flux LNA Loss LNA Nf LNA Gain Coax Loss Rx Nf Spillover Feedthru Sun Y

5.34 dB

Tx A Output Power Transmission Loss Power at Feed Moon Y

30 Watts 14.77 dBW 0.5 dB 27 Watts 14.27 dBW 30,059,326 W EIRP

Ground Temperature 290 *K 17 *C

Tx T*K 35.5 *K = 0.50 dB Receiver Noise Temperature

Sys T*K 76.6 *K = 1.02 dB System Noise Temperature

Dx Station as received at Home Station ... 15.2 dB

Home Station as received at Dx Station ... 9.6 dB

Moon Distance Perigee Apogee 358000 kms

B (Dx Station) Default

32 MHz 260.33 dB 20 K 150 Hz 1.00 mm 12.7 mm -153.0 dBm -33.0 dB

frequency Path Loss T Sky Rx BW -26.2 dB Effective ground T*K 235 *K
0.01 dB C/S - ground -> 3.1 dB

GET PS SFU DATA << Your last sfu data record has been loaded.

6.8 *K 17.2 *K 45 *K 1 *K

80 0.10 dB 0.25 dB 24.0 dB 5.3 dB 1.0 dB 70 *K 25 *K 1.6 dB

Star Flux LNA Loss LNA Nf LNA Gain Coax Loss Rx Nf Spillover Feedthru Sun Y

0.00 dB

Tx B Output Power Transmission Loss Power at Feed Moon Y

112 Watts 20.49 dBW 0.5 dB 100 Watts 19.99 dBW 1,638 W EIRP

Single Yagi Gain in dBd 10.50 dBd 1 38.3° 10.50 dBd

Parabolic Reflector Feed Type EIA Dual - Dipole (reference) Linear Pol

Diameter Size f/D Efficiency Beam Width Gain

305.00 m Metric 0.43 59% 0.16° 1124428 58.36 dB

439.2 Lambda

Home Station ... Y Factor Calc Noise Flux Quiet Flux

Noise Source Quiet Source

☐ Sagittarius ☐ Termination

☐ Cassiopeia ☒ Aquarius

☐ Cygnus ☐ Leo

☐ Taurus A ☐ Taurus

☒ Virgo ☐ Termination

Noise Information Y Figure Notes

290 *K 20 *K

Point Source Y Factor

290 *K 278 *K 4528 *K

Aperture Source Y Factor

Yagi Array Number of Yagis E 40.6°

Single Yagi Gain in dBd 10.00 dBd 1 40.6° 10.00 dBd

Parabolic Reflector Feed Type VE4MA (Super) Linear Pol

Diameter Size f/D Efficiency Beam Width Gain

2.50 m Metric 0.43 63% 19.43° 81 16.90 dBd

Dish diameter is less than 10 l

Effective Aperture 43091.90 M²

Moon Beam Fill Factor

Based on VK3UM EME Tool For 58 dB gain System

Power Tubes

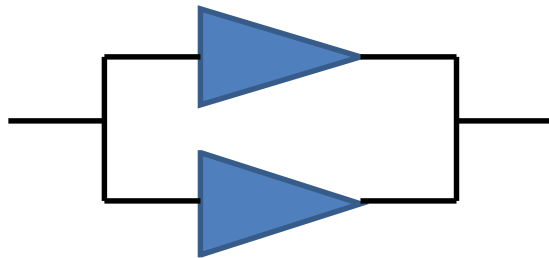
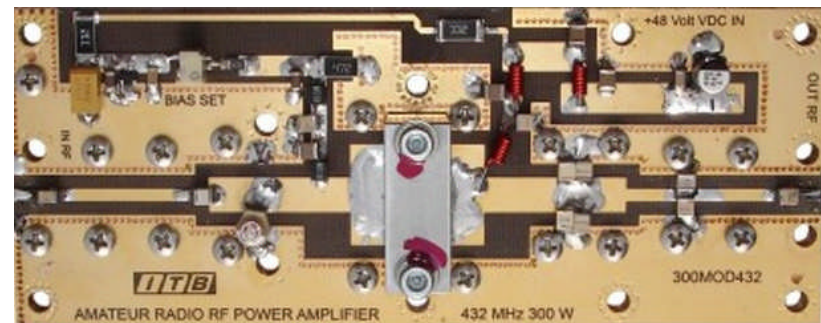
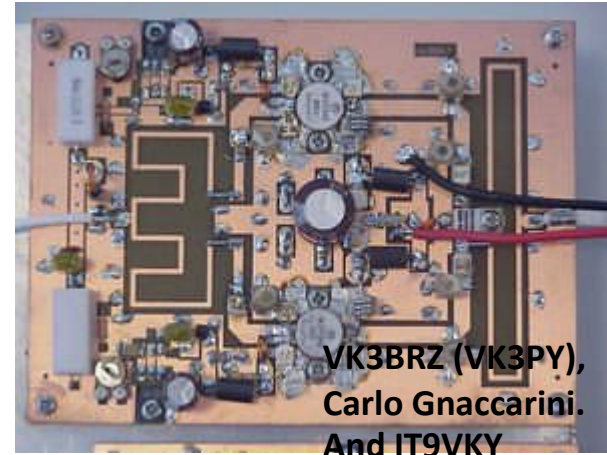
With modest power supply requirements – 1 tube

- 4CX250
– 250 to 350 w
- 8930
– About the same, AM-6155
- 3CX400 / 8874
– 350 to 450 w
- 3CX800 or 4CX400A/GS36B
– 500 to 700 w



Solid State Power

- 100 W
 - Commercial - D1010 (using)
 - MRF 648
- 150 W and Higher
 - Combining MRF648s
 - FET Kits



MRF6V2300N or MRF6V4300N

- 4300 is newer with higher f_{max} , same power

FreeScale Semiconductor
Technical Data

Document Number: Order from RF Marketing
Rev. 4, 10/2005

✓RoHS

RF Power Field Effect Transistor N-Channel Enhancement-Mode Lateral MOSFETs

Designed primarily for pulsed wideband large-signal output and driver applications with frequencies up to 450 MHz. Devices are unmatched and are suitable for use in industrial, medical and scientific applications.

- Typical CW Performance at 210 MHz: $V_{DD} = 50$ Volts, $I_{DD} = 900$ mA,
 $P_{out} = 300$ Watts
Power Gain — 27 dB
Drain Efficiency — 55%
- Capable of Handling 10:1 VSWR, @ 50 Vdc, 210 MHz, 300 Watts CW Output Power

Features

- Integrated ESD Protection
- Greater Negative Gate-Source Voltage Range for Improved Class C Operation
- Excellent Thermal Stability
- Facilitates Manual Gain Control, AGC and Modulation Techniques
- 225°C Capable Plastic Package
- RoHS Compliant

MRF6V2300N
MRF6V2300NB
PREPRODUCTION

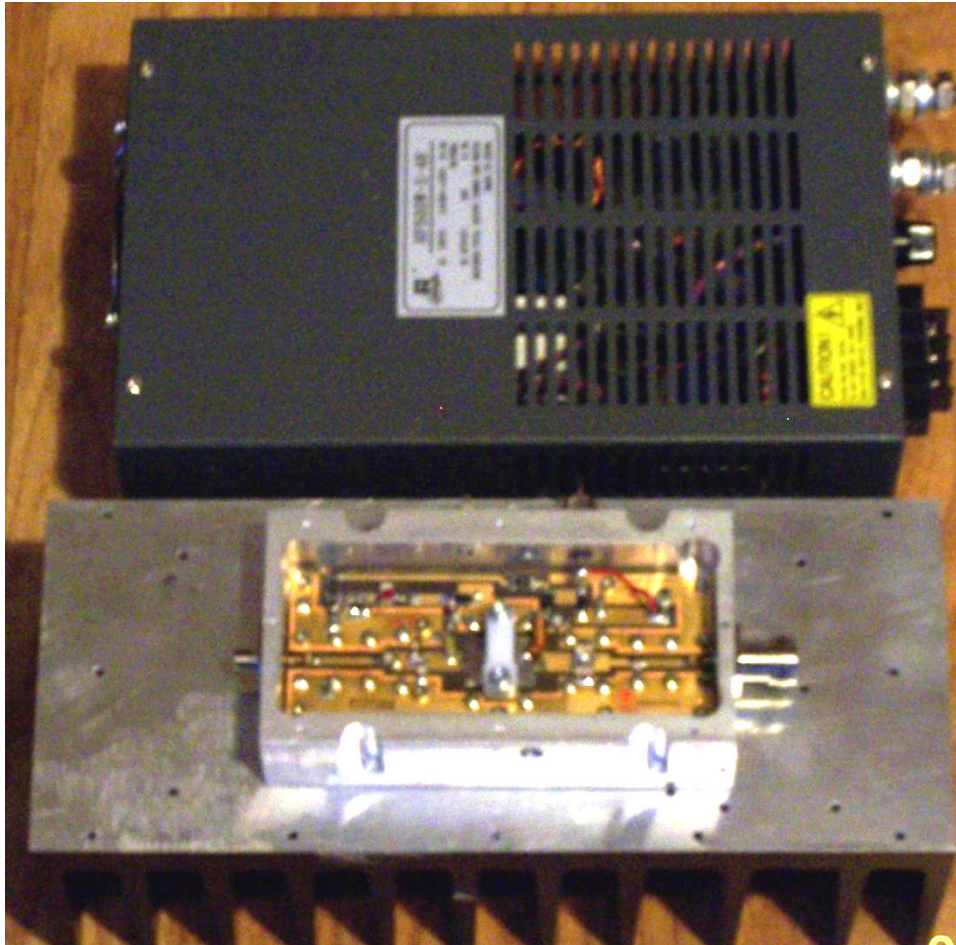
10-450 MHz, 300 W, 50 V
LATERAL N-CHANNEL
SINGLE-ENDED
BROADBAND
RF POWER MOSFETs

CASE 1489-03, STYLE 1
TO-270 WB-4
PLASTIC
MRF6V2300N

CASE 1489-04, STYLE 1
TO-270 WB-4
PLASTIC
MRF6V2300NB

PARTS ARE SINGLE-ENDED

Amplifier Pallets



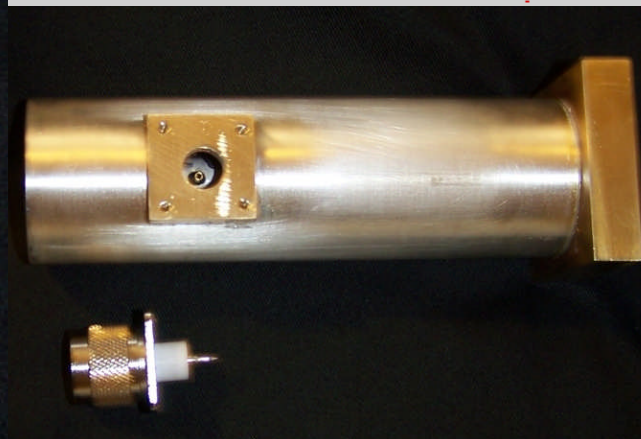
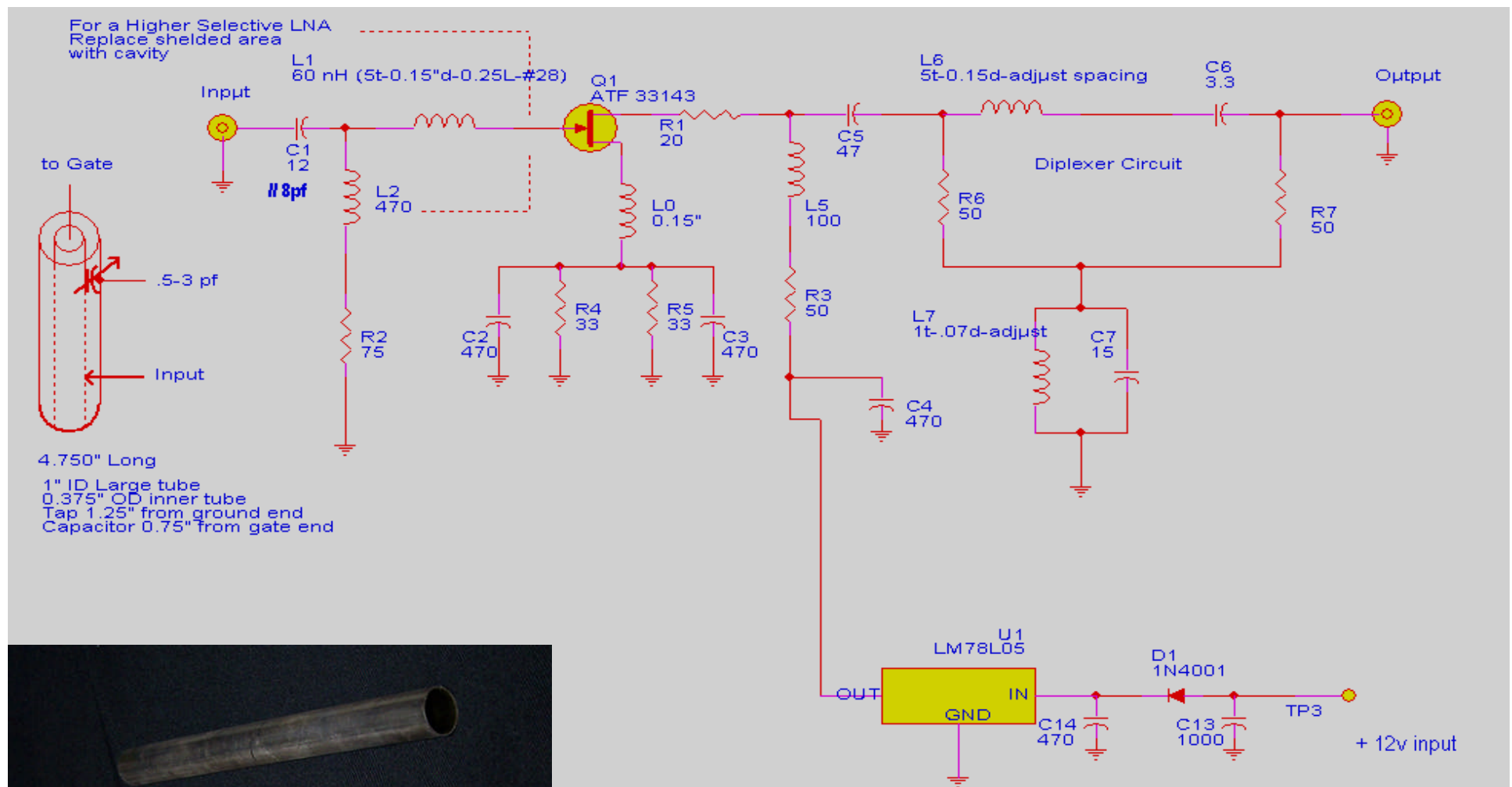
- 70 cm Amp Pallet
- 3W in – 300W out
- PS 48 V @ 11 A
- Cost ~ \$400 US,
- Supports \$75
- \$120 PS
- Device alone \$100

Low Noise Amplifiers



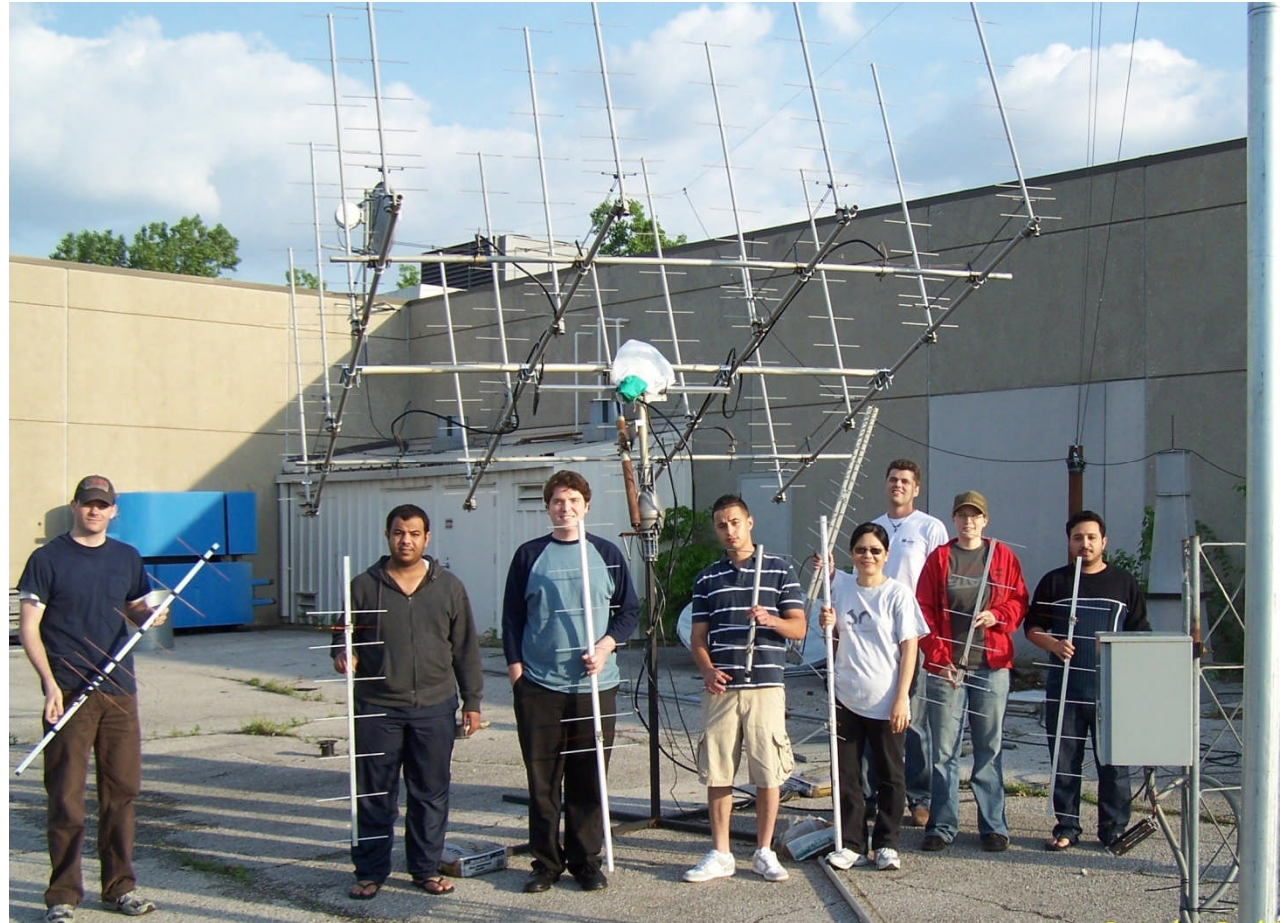
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- Simple matching circuits proved to perform well with higher IP devices ... ATF33143, n/f well below 0.4 dB
- Low input Z of these devices also perform with wider band width, cavity input has small effect on circuits BW.
- Smaller gate width devices yield a higher input Z, narrower band width performance is achieved with cavity input. NF ~ 0.25 dB
- System performance is noticeably better with cavity circuit in high RF environments.



Antennas

- Main System
 - 16 * 10 Element K5GW Yagis
 - 24 dBD
- Yagi or Dish
 - > 16 dBD



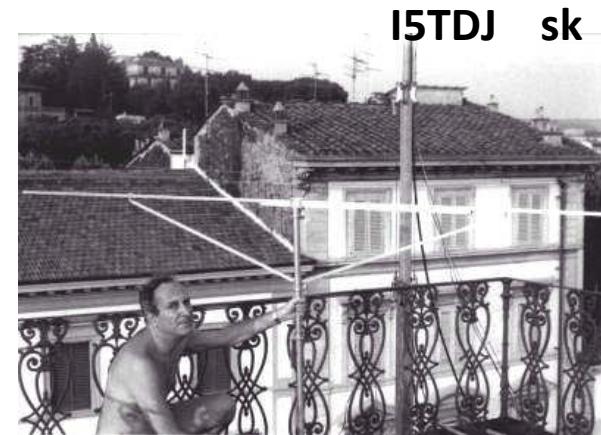
First time on 70cm EME was in a bed of a Truck!

Used W1JR roadshow - 8 F9FT's



WD5AGO

Single
Yagi
EME



17 dBD <\$100, 500W <\$500, 18 CW Qso's
Priceless!

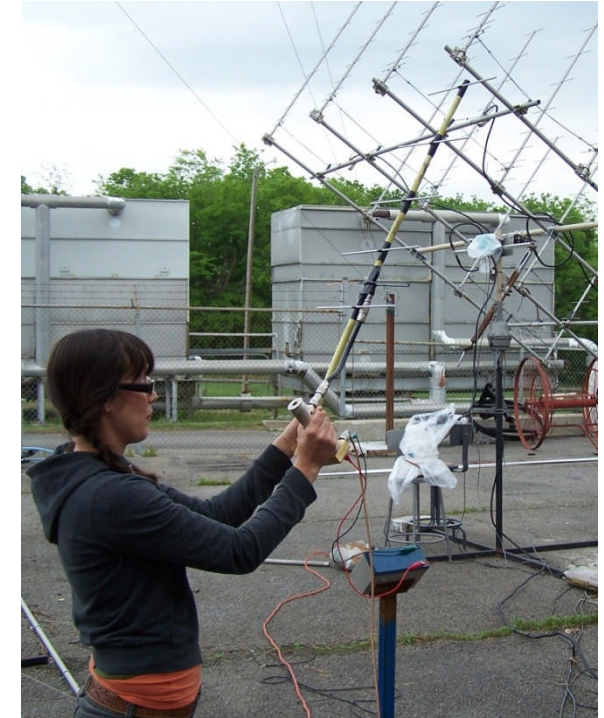


Yagi Antenna Designs

- The WWW is full of design articles
- For a fixed yagi system, something longer than 4m or about 24 elements or more each.
- Good antenna patterns, low system noise
- Over 15 initial CW EME contacts were made with one - 13 wl yagi and 500W
- Smaller antenna stations available using digital modes

Student Antenna Lab - Arecibo

- Rules: Based on the VK3UM EME calculator budget, antennas in the 10 dBD range should be successful. On 70cm, this is an antenna about 1m long.
- Build what you would like as long as the antenna is less than 1m long.
- RX only



Success!

- All 70cm Antennas built for the Arecibo Test were able to pick-up the signal as heard through the speaker, on Class day, Friday
- Smallest was a 4 element “YO” yagi
- Provided the Cavity LNA was placed inline
- On Friday of the Test, KP4AO was only using 30W!
- Based on the Data, having already worked KP4AO the month before, no transmission were made with the 1m antennas which also made it safer for student testing

Table1: Antennas (Number of Elements - Design - Length in Inches) 1m or less	Gain Theory dBg	KP4AO Signal 0 - 5	Rank w/LNA	Builder
8 — WU Yagi, F Dipole — 39"	11	5	1	J. Hirsch
8 — WU Yagi, F Dipole — 39"	11	5	2	A. Wheeler
7 — Yagi, F. Dipole — 32"	10	4	3	J. Long
7 — YO Yagi, HB, T match — 32"	10	4	4	T. Henderson
8 — VJB Yagi — 38"	11	3	5	A. Almlihi
8 — VJB Yagi — 38"	11	3	6	A. Alzahrani
8 — VJB Yagi — 38"	11	3	7	J. Farnsworth
8 — VJB Yagi — 38"	11	3	8	G. Lai
8 — WU Yagi, T match — 39"	11	2	9	J. Owen
5 — Taper Yagi, T match — 20"	7	2	10	E Cano
5 — Quagi — 32"	8	2	11	B. Hanna
6 — Comm Yagi, 1/2 Dipole — 24"	8	2	12	T. Moore
6 — VJB Yagi, J match — 26"	8	1	13	L. Saunders
4 — NBS Yagi, T match — 15"	6	1	14	E. Govea
25 — LOG 150 — 1300 MHz — 60"	4	0	15	TCC
160 — GW Yagi Array, 16 x 10 — 72"	24	+20 dB	S6	12.5 dBg each

Life on Mars? *life on 70cm EME!*

- Simple yagis and modest power can be used to make EME contacts on this world wide band. A LNA is needed for most QSOs
- Even long single yagi operation is possible
- CW and possibly Digital will be used during the ARRL contest, 73s